The application of community service learning in science education

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Abstract

Learning of science has been traditionally conducted in classrooms or in the form of lectures. Science education is usually context-specific learning as students are taught a particular module of content in class. In problem-based learning, they are provided with examples of problems in which they learn how to solve these types

of problems. However, when students encounter a similar problem in a different context, they are unable to apply their prior knowledge to this new situation. The key components of authentic science learning are the external world and the individuals. Although the classroom aims to retain such authenticity by providing real-life problems to solve, it will never be the same as students' personal experiences in the real world – the community service learning (CSL). CSL integrates science learning into the real-world situations within a community context. It is one of the active learning strategies that aims to foster better understanding of course content and broader appreciation of the discipline. This CSL study focuses on the community service project and the individual critical reflection. CSL provides a real-life working environment that lead to excellent learning outcomes for the students as well as strengthens their individual social responsibility. This paper provides an example of the application of CSL within a tertiary institutional context. The CSL project involved student volunteers to set up a bioreactor for biogas supply within a local community of Chiang Rai, Thailand. In particular, it demonstrates students' reflection and their personal experiences in learning science beyond the classroom. Based on quantitative and qualitative data from 22 participants, it demonstrates the meaningful impact of CSL on student learning outcomes. Results show CSL creates an active yet meaningful learning of science and socially responsible citizens. Finally, this paper will also discuss the implications of learning science in an informal yet authentic context.

Keywords: authentic science learning; community service learning; critical reflection; social responsibility

Introduction

Service learning is an experiential yet authentic teaching strategy to deliver learning and service to the community (Soslau & Yost, 2007). Service learning projects are more evident in States as the National Service-Learning Partnership provides extensive research pertinent to the benefits of service learning (Billig & Brown, 2004).

Service learning is considered as a powerful instructional tool that may impart impactful benefits to the participants and it also synonymously linked to community service. It is "an authentic instructional method and service to the community" such that students learn and develop through active participation in the

context of community events (Soslau & Yost, 2007). Such learning enables students to make connection between the contents learnt in the classroom and their service learning experiences.

Besides enhancing real-life connections to subject matter learnt in classroom, service learning is viewed as a transformative educational experience in the context of authentic community learning (Elwell, 2001; Brown *et al.*, 2007; Parker, Myers, Higgins *et al.*, 2009). Community service learning (CSL) thereby integrates science knowledge into the real-world situations within a community context. This is an active learning-cum-teaching strategy that aims to foster better understanding of course content and broader appreciation of the discipline.

This research describes the theoretical framework and methodology involved in the overseas community service learning in a village of Chiang Rai, Northern Thailand. The study aimed to evaluate students' perceptions of the value of CSL project in advancing the learning outcomes. Findings from this preliminary study suggest that CSL is beneficial to the students' learning and development, as well as a well-defined research on CSL for future agenda may be conducted.

Theoretical framework

Experiential learning is "the process whereby knowledge is created through the transformation of experience. Knowledge results from the combination of grasping and transforming experience" (Kolb, 1894, p. 41). Kolb's learning cycle starts from concrete experience to abstract conceptualization. In service learning, participants get to immerse themselves in the experience and they articulate such experience through reflective observation. Through reflection, they process their thinking, try to integrate and understand their experiences. This may lead to theory and strategy construction, which is also knowledge construction. The internalization and externalization processes are part of the problem-based learning (PBL) cycle.

Community service learning is not a new concept, rather it is the tradition of 'learn and serve' which is rich and experiential (Parker *el al*., 2009). Classical theories of Aristotle and Plato promoted education as a means to produce good persons; develop good personality as well as apply knowledge in pursuit of goodness. Dewey's (1938) theory of learning espouses the importance of academic service

learning, that is, learning through experiencing and learning from doing (Parker *et al*., 2009).

Pedagogically, service learning is integrated into the real world through experiential learning, perspective-taking and cognitive development. Lave and Wenger (1991) asserted that learning results from activity, context and culture in which it is embedded. Hence, social participation is involved whereby each individual is an active participant within the community. Service learning also requires learners to solve problems in the real world.

Recent development in service learning theoretical framework includes the social learning and cognitive learning models (Flecky, 2011). According to Hung and Nichani (2002), learning clubs, learning communities, and communities of practice were examined from a Vygotskian perspective. Vygotsky's (1986) concept of zone of proximal (ZPD) put forward the concept of social situatedness that describes the development of individual intelligence requires a social and cultural embedding. Such intelligence is viewed as dynamic rather than a fixed characteristic and it is believed that the child can be guided towards a more sophisticated learning with adult help or mediation. Social situatedness is also the ability to engage in acts of communication and participate in social practices and 'language games' within a community (Vygotsky, 1986). There is also epigenetic development which includes the development of physical, social, linguistic skills along a progression level, coupled with the physical and social environment.

CSL is open to a diverse range of disciplines and has been more adopted in tertiary institutions. CSL can be incorporated in disciplines such as social work, nursing, education, business and engineering (Karasik & Wallingford, 2007). Positive impacts such as participants' personal growth, problem-solving abilities, intellectual development and cognitive development were documented (Howard, 2003; Ngai, 2006; Parker *et al*., 2009).

CSL is not compulsory within our local education system, thus such research is not vigorous here. However, States and Australia have been doing CSL and service learning (SL) research over more than a decade. SL has its benefits and it may be eventually integrated as a compulsory unit or module for the local schools and higher learning institutions. Potential outcomes of implemented service learning curriculum are increased student engagement, improved critical thinking and problem-solving skills in dynamic settings (Meaney et al., 2008). The aim of this

research is to investigate an exploratory study of integrating CSL into the science curriculum of a tertiary institution.

Context for CSL

CSL is not a compulsory unit or module for the tertiary students. Rather, it is voluntary and students get to go to an Asian community in Chiang Rai, Northern Thailand. This CSL is usually delivered during term vacations.

The context of CSL is similar to a PBL classroom. The students are divided into groups and they engage with the problem among their peers within their individual group. The role of a staff leader is to assist the students in recognising the cognitive processes they have used in problem-identification as well as problem-solving. They go through enactment and embodiment in social situated learning.

Figure 1. Setup of bioreactor

Figure 2. Bioreactor with some biogas

3 main objectives for this project were: students would contribute to the local community for this SL project through (a) exploration of the availability and suitability of local animal wastes by generating biogas and producing high-quality organic fertilizer as a by-product; (b) setup of bioreactors (see Figures 1 & 2) for these animal wastes and producing sufficient biogas for daily cooking (see Figure 3)

and, thus, reducing the amount of wood fuel used by household; as well as (c) monitoring and troubleshooting (if any) the performance for the bioreactors.

Figure 3. Animal wastes e.g. cow dung

Figure 4. Mixture of cow dung and microorganisms

Participants were required to understand the principle of bioreactor and its sustainability. Another term for such bioreactor is an anaerobic digester. Anaerobic digestion of organic matter and its technology has been widely used not just because it has shown effectively treating the organic wastes, but simultaneously producing a renewable energy source, i.e., biogas. Anaerobic digestion uses microorganisms in the animal or plant waste (see Figure 4), which is in the absence of oxygen, to produce a mixture of methane, carbon dioxide and other gasses. Animal wastes, such as cow, elephant and pig dung, are easily found but are often just put aside near the farm and neglected in many South-East-Asian countries, including Thailand. By putting these wastes away in the bioreactor, besides treating the wastes to prevent pollution, it also produces clean energy which is biogas. Biogas can be used for direct combustion, e.g. cooking, lighting, etc. This has also created economic values to benefit the poorer villagers living at the rural areas.

The Mirror Foundation is a non-governmental organization that works with over 30,000 hill tribe people (primarily Akha, Kaen, Thai and Lahu), empowering them to improve their lives and deal with the many problems they face, including poverty, trafficking of persons, drugs, and the lack of Thai citizenship (www.mirrorartgroup.org). Participants and The Mirror Foundation worked together to design the bioreactor and to identify suitable sources of animal wastes for the biogas project. Through discussion and physical work to collect the animal wastes and set up the bioreactors, the participants not only learnt culture from one another, but also put in “practical” use for what they had learnt in class. The Mirror Foundation will continue to monitor the project after participants have left the site.

The experiences and outcomes gained from the project will help to improve the design of the bioreactor and set up more biogas projects in the future to benefit the needy.

In the local education system and institutional setting, there is no assessment and no grade given to these participants of service learning. However, in this study, they were assessed based on their commitments during the process of pre-trip preparation as well as during the trip. In addition, evaluation and reflection assessments were completed by these students (see Tables 1 & 2).

This CSL study focuses on the community service project and the individual's critical reflection. CSL provides a real-life working environment that leads to excellent learning outcomes for the students as well as strengthens their individual social responsibility. Queensland University of Technology (QUT) used service learning not only as the pedagogy to provide their graduates with excellent learning goals and critical reflection, but also to focus on their civic responsibility (QUT, 2011).

Significance of study

In the past decade, the agenda of SL has become prevalent in school settings. The positive educational outcomes cited for the adoption of service learning are increasing student knowledge, understanding of the community and its real needs, as well as students' altruism (Billig, 2000). However, there is still limited empirical research on the community service learning and its educational outcomes. The term "CSL" is not as commonly used as "SL". In a recent review by Grange (2007), there has been an increasingly interest in CSL as it was placed on a higher agenda of higher education. However, there is no empirical research that conducts the implementation of CSL into a science curriculum of a local tertiary institutional setting. Hence, there is a need to investigate the application of CSL in the higher science curriculum and its positive educational outcomes.

The purpose of this study is to investigate the learning outcomes of the integration of CSL into academic curriculum of the students and provide sufficient time for the students to reflect on such learning experience. This study also aims that CSL will enhance students' conceptual understanding on biogas production and the principle of bioreactors.

Method

A group of 22 students and 2 staff leaders from the faculty of applied science of a tertiary institution were involved in the 11-day real-life events in a community of Chiang Rai, Thailand. Contact time was about 8 to 10 hours every day over a week. The cohort consisted of 12 graduating students, 8 third-year students and 2 second-year students. Comprised of local students, majority came from environmental science course while minority was from biotechnology and biomedical courses. The ratio of females to males was 1:2. The age range was between 18 and 22 years old.

A variety of methods was utilized in this study to gain an insight of the effectiveness of the CSL experience. This included an evaluation questionnaire, reflection questionnaire and reflection journal. The evaluation questionnaire, termed as Community Service Learning Questionnaire (CSLQ) consisted of 10 items: 1 question presented students with four choices ranging from 'excellent' to 'poor'; another presented them with only 'yes' or 'no' options; and remaining 8 statements were assessed with 5-point Likert scale (see Table 1). The statements of this questionnaire were adapted from Parker *el al.* (2009). The statements were modified to fit into the context of learning and the community (Hill Tribe village). Examples of the statements are "I established rapport with villagers at the Hill Tribe" and "I can see the link between what I learnt in PBL and the objectives of this SL." The reflection questionnaire that was provided by the institution consisted of 7 open-ended questions for the students to reflect and share the CSL experience. 1 of these 7 questions also included four choices and students had to explain their selected choice. The reliability of the scale (Cronbach's α) was .97 in this sample.

The questionnaires were administered to all student volunteers at the end of the CSL trip, in Chiang Rai. All of them responded to this evaluation questionnaire and reflection questionnaire. These students also submitted their reflection journals and the data was coded, with clustered categories and derived themes.

Table 1. Student volunteers' responses to evaluation questionnaire

	Question	Excellent (%)	Good (%)	Fair (%)	Poor (%)	
Q1	What is the overall impression of the community service learning in making a contribution to the Hill Tribe?	11 (50%)	11 (50%)	0	0	
	Question	**Yes (%)**		**No (%)**		
Q2	I have participated in volunteer work before.	11 (50%)		11 (50%)		
	Questions	**Strongly agree (%)**	**Agree (%)**	**Neutral (%)**	**Disagree (%)**	**Strongly disagree (%)**
Q3	I established rapport with the villagers at the Hill Tribe.	6 (27.3)	12 (54.5)	4 (18.2)	0	0
Q4	I can see the link between what I learn in PBL and the objectives of this SL.	2 (9.1)	16 (72.7)	4 (18.2)	0	0
Q5	I can connect my science disciplines learnt in 2nd and 3rd years to the objectives of this SL.	3 (13.6)	11 (50.0)	6 (27.3)	0	2 (9.1)
Q6	As a result of my community service experience, I gained new insights into this tribe.	12 (54.5)	9 (40.9)	1 (4.5)	0	0
Q7	As a result of my community service experience, I gained an awareness of community issues particularly in relation to this project.	15 (68.2)	6 (27.3)	1 (4.5)	0	0
Q8	As a result of my community service experience, I would like to continue my volunteering as a part of my further development.	13 (59.1)	6 (27.3)	3 (13.6)	0	0
Q9	I understand myself better after this trip.	12 (54.5)	6 (27.3)	4 (18.2)	0	0
Q10	I feel more confident working in the real world.	10 (45.5)	8 (36.4)	4 (18.2)	0	0

Results

Evaluation questionnaire

Overall, students perceived the entire CSL experience as positive (Table 1). They gained insights such as opportunities for personal development and growth, hence acquired the real world skills.

Of the students who participated in the evaluation questionnaire, 50% (n = 11) reported that their overall experiences on the community service experience was 'excellent' whereas the remaining half reported as 'good'. Similarly, 50% had involved such volunteering experience before. Over 80% (n = 18) strongly agreed or agreed that they had established rapport with the villagers there as well as could make connection between PBL and this CSL.

This community service experience was beneficial to the students' learning as 63.6% (n = 14) could connect to their prior science knowledge to this service learning. However, 9.1% (n = 2) indicated that they did not make connection between the science disciplines and the project. Over 90% (n = 21) affirmed that they had gained insights and awareness of the community issues related to the project. About 86% would like to continue volunteering as a part of their future development. In addition, over 80% strongly agreed or agreed that they understood themselves better and were more confident in working in the real world.

Although the results from this study were positive, they were unable to predict if such experience would have long lasting effect on the students' development when they are working in the real world.

Critical reflections on the community service experience

The reflective questionnaires were completed by the students at the end of the project. The students responded to seven questions (Table 2) and they were very positive about the whole experience. The key element in this experience was the impact of learning. They felt they had benefited significantly in terms of personal development and civic responsibility. 21 agreed that this experience was meaningful. 3 stated that the process of the biogas project was the most significant experience whereas 19 affirmed that it was the culture and lifestyle of the village. In particular, one student commented that the community service experience had left a significant impact to him whereas 21 agreed that such experience had influenced their personal values and thoughts. In addition, 22 agreed that this service learning experience was transformational, with 15 agreed that it was the most transformational experience they ever had. The last question fell into the category of civic responsibility and all the participants agreed that 'no one owes them a living'.

Table 2. Student volunteers' responses to reflection questionnaire

	Questions	Number of Responses	Students' comments
Q1	Was the service meaningful for the overseas community?	22	21 agreed it was meaningful. 1 commented, "I hope it was meaningful".
Q2	Were the facilitation sessions interesting and useful?	22	22 agreed. 7 stated that experiences were shared and they were meaningful sessions.
Q3	What is the most significant moment in this SL programme?	22	3 stated the biogas project and the construction of the anaerobic bioreactor. The rest stated the culture and lifestyle of the village.
Q4	What lessons could you learn from this overseas community?	22	7 stated they had learnt survival skills. 15 stated they were more appreciative of the things around them.
Q5	Has the SL experience influenced your personal values and thoughts about community service?	22	21 agreed. 1 stated, "SL experience did not influence my personal values and thoughts about community service but it did leave a significant impact."
Q6	Did the SL experience leave an impact on you? • It is by far the most transformational experience I have had. • It is one of the more transformational experiences I have had. • It is just an interesting programme with not much impact. • It is a disappointment for me. It has no impact on me at all.	22 15 7 0 0	2 commented that they had been to such similar SL trip before.
Q7	It has been said that "no one owes us a living". How does this statement apply to you?	22	22 agreed with this statement. Some selected comments: • "No one will spoon-feed us" • "…we determine how we want to lead our lives…" • "The community can lend a helping hand; but we have to put in our own effort to sustain better condition." • "..we have to be give and take…" • "We create our own future and walk our own path."

Students' reflection journals were coded into the following four categories (Parker *et al.*, 2009):

1. reflection on personal role within the group setting;
2. increasing awareness of community issues;
3. lessons learnt about non-governmental organisation; and
4. challenges faced.

Table 3. Selected students' comments from their reflective journals

Student	Comments
1	"This SL trip I enjoyed it a lot; I learnt a lot of things such as digging requires a lot of techniques. … The working together to build biogas reactor requires lots of teamwork and hard work. Overall, this trip is very meaningful and memorable."
2	"The experience brings out the real character of one's self. … To them is normal, but to me I think it's hardship."
3	"… construction of biogas reaction… I was surprised how the Thai people were able to think of such innovative ideas with so little raw materials. This example totally changed my perception of Thai people, and I grew to respect them and their way of living."
4	"Doing hands-on on the bioreactor also gives me better understanding on how it works. Also providing benefits for the local, as they can save for cooking using biogas."
5	"This trip to Chiang Rai was meant to build a biogas reactor for a school … Having learnt about the biogas system, the next was to build it in school. I understood that with this system, they would save a lot of money for the village which isn't very developed."

Overall, students expressed positive feedback about the whole CSL experience. Majority of students demonstrated positive reflections on their personal role towards the bioreactor and biogas project (see Table 3). They gained increased awareness of the community issues in rural areas such as Chiang Rai. As these 22 student volunteers were bred in Singapore, they did not have such rural exposure. Besides learning lessons about utilising raw materials such as animal wastes to produce biogas for cooking purpose and fertilisers for vegetables cultivation (Figures 5 & 6), they also learnt about the cultural values from the villagers and the roles of non-profit organization, Mirror Foundation.

Figure 5. Animal wastes mixed with soil

Figure 6. Using animal wastes for farming

Students realized the importance of the biogas project in a rural setting, the team's effort and rapport in order to complete the project on time. Biogas is not common in cities or developed countries. However, for developing countries such as Chiang Rai, some of the rural areas use raw materials for cooking purpose. Gas is considered as an expensive source for cooking and biogas is an alternative to most rural communities. Many learnt the skills of biogas construction in which they would not have experienced from textbooks or in classroom. One participant stated, "With awesome friends with me and meaningful project waiting for us to complete". Indeed, he realized the importance of individual contributions in order to maintain a healthy working environment and to complete the given task.

Majority regarded such experience as a lesson in life and issues they need to be aware of in the workplace. Moreover, they were appreciative that such opportunity allowed them to realize the way in which the villagers operate in such a setting. One of the student's written comments was "an opportunity for me as an eye-opener to see the world in a different view and not to look down on people who are not as fortunate as me because that is their way of living". Hence, students developed a greater understanding for the role of non-profit organizations.

Finally, there were some challenges faced during the project, particularly the process of biogas construction. An example was the collection of the cow dung as the raw material to obtain biogas was manure. Despite the hardship faced by the students, they were very positive. Comments expressed by them included "from digging the steep slope to the collection of cow dung and pig dung, mixing the dung, is something that is worth doing" and "I had an awesome time doing hard work like digging the ground, collecting cow dung". Hence, the students were able

to turn such challenges into a positive learning experience which is a reflective nature in this study.

Discussion and Conclusion

The results of this CSL study were positive, as supported by the research findings (Eyler & Giles, 1999; Parker *et al*., 2009). Eyler & Giles reported that 80% of 1100 students agreed that their service learning experience was 'good or excellent'. Conrad and Hedin (1991) reported that service learning offers connection between academic contents and real world problems.

Through engagement between the academic contents in school and real-world problems in authentic setting (i.e. CSL), students build their competence as they have more control over their learning, hence promoting positive learning (Billig, 2006; Scales, Roehlkepartain, Neal *et al.*,, 2006). CSL provides the characteristics of effective learning environment as students were more engaged in their learning and had better understanding on purpose of bioreactors. What they had learnt in classroom in terms of theory and principle of biogas might not appear meaningful to them till they had experienced the real process of constructing the bioreactor. They also learnt how to make the bioreactor works so as to produce sufficient biogas for cooking purpose. Therefore, such experiential learning had provided them invaluable experiences including meaningful learning through integration of classwork and community life (Zeidin, 2004; Scales et al., 2006).

Specific comments such as 'meaningful', 'eye-opener' and 'significant impact' suggested that students perceived the community service experience as being beneficial to their learning and an opportunity to achieve positive outcomes. These were consistent with findings of Markus *et al.* (1993), as community service has many creditable or commendable purposes and outcomes. Community service not only fulfills civic responsibilities to the community, but also enables one to gain insights that are beneficial to the personal and career development.

On the contrary, this study had several limitations. As it was not a compulsory module, the ratio of staff to students was 1:11. Hence, the sample size was not big enough to conduct a large-scale quantitative research. The maximum number of students that could take for each overseas trip was around 22 students. The adjustment of sample size would have to take into consideration to permit more

students to be exposed to CSL for each trip. As this is an exploratory study conducted in a tertiary institution, there is a need to conduct further research on the educational outcomes of CSL.

In addition, majority of the students came from environmental science background. Minority of them were from biotechnology and biomedical science background. It will be more relevant if the participants came from environmental science field as they had gained theoretical knowledge of bioreactor's construction and biogas production; hence, more applicable to the practical aspects in Chiang Rai. However, the knowledge of biogas and its principle were not too abstract for the biotechnology and biomedical science students. They could pick up the theory fairly well during the pre-trip preparation.

Last but not least, the self-evaluation for this community service experience and participation may be biased which led to more favorable responses on the assessment instruments. Students with prior community service experience might have a significantly greater change in their responses to survey questions than those who have no prior experience (Piper, DeYoung & Langsam, 2000). In this study, 50% had prior experience whereas the remaining 50% did not have any. The motivation level of these students may differ. For instance, the ones with prior experience commented that this CSL trip was one of the transformational experiences whereas the ones without prior experience responded positively that this trip was the most transformational one (Table 2). Nevertheless, service learning experience is active and dynamic. The results might be biased due to the subjectivity of the evaluation tools. However, the main objective was to assess the students' perceptions of service learning in a rural community context which proved to be a success. In addition, the students were more aware of their own learning and value of community service experience based on reflection questionnaire.

Implications of this study

Aligned with the aims of this research, participants should understand the purpose of this CSL and have clear understanding of their expectations. The briefing and introductory sessions prior to the CSL trip should be conducted in clear and systematic manner. There is a necessity for participants and staff leaders to avoid any mismatched expectations which may result in conflicting interests and disagreements during the trip.

The partnering non-governmental organization and community partners must work with institution closely to ensure that CSL is structured and carried out properly. This is important as the structure and context of CSL should be consistent to the learners' outcomes. For future application of CSL into school curriculum, detailed planning and implementation time must be supported.

In conclusion, although this study was considered as a small-scale research, its findings could be considered as a preliminary platform to conduct more of such research in future. The future agenda will consider the longitudinal study of service learning and a larger scale of study.

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